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VALUATION AND ACCOUNTING FOR ENVIRONMENTAL AND NATURAL RESOURCES

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1. INTRODUCTION

Kautilya, in his book on the Indian economy almost about 1850 years ago, had drawn a distinction between different types of forests for better management. He distinguished between 'productive and non-productive' forests. Interestingly, the classification suggested by him finds an echo in the distinctions made in present day literature between use and non-use values of resources. [1]

Almost around the same time, about 550 BC back, Confucius, a great Chinese thinker, also was talking about value and price. While talking about production, consumption and pricing he argued for many producers and few consumers; the former to be active and the latter to be thrifty; asked the producers to wait until a proper price is offered. Today the notion of value and price are quite mixed; for most of the people they are one and the same, for many others it does not matter if they are different.

While talking about man-made resources (often called as capital), starting from Adam Smith to the present day thinkers, a clear distinction has been made between price and value.[2] (When it comes to environmental and natural resources, this is a matter requiring a much more serious attention. This monograph goes into this specific issue.

The next important issue in environmental economics is resource accounting. It is some times difficult to understand 'natural and environmental resources' as natural capital. It is a stock in exactly the same sense that man-made capital is addressed. It has the characteristics of repeated use, depreciation and possibility of replacement, and can enjoy rent for its use or abuse. It's accounting however, both as a stock and flows (i.e., use or non-use benefits from it) are not yet within the framework of income accounting.

The world of income and resource accounting has graduated quite a lot (Stone, 1961; Hicks; 1941, 1946). The 'Tableau de economie' by Quesney in the seventeenth century, the Input-Output Transactions Table by Leontief (1966), Social Accounting Matrix (SAM) by Taylor (1983) and more recently the System of Environmental and Economic Accounting (SEEA) as developed by the United Nations (1993) are some landmarks in the course of this development. But in the process of developing such income accounting methods, accounting for natural resources was not given a priority. It was perhaps by the United Nations Conference on Environment and Development (UNCED) in 1992 which, centuries after Kautilya, reopened the issue of natural resource accounting as a basic indicator for better management of natural resources and understanding of welfare at the global level. In the Indian context, the issue of accounting is much more complicated, because of not having a market for many of those resources. This issue of accounting will also be dealt in this monograph.

Finally, some case studies from India are presented illustrating the methodology of valuation and accounting for environmental and natural resources.

2. VALUATION OF NATURAL RESOURCES

Economic valuation is, in the ordinary course, conceived of as putting a cardinal number on utility accruing from current consumption, either through the institution of markets or outside of them. To the extent the utility preferences are reflective and transitive, it is an indicator of willingness to pay for the consumption benefit one derives from it. In that sense, it captures the Use value of consumption. The price of that consumption however, is what the consumer actually pays. The price of commodities and services are fixed based on various principles such as Exchange value, Labour theory of value, notional or administered price and so on. While the exchange value can depend upon what the market can bear, the labour theory of value at best can provide clues on relative prices.

Use value is defined as accruing from those benefits, which are attributed to present consumption of the resource. A distinction is made between direct and indirect use values. Direct use value may emerge from exchange or outside of exchange through self-consumption of resources to which individuals have access. For instance, extraction of timber or non-timber forest resources or the accruals of the services of tourism generate direct use value. By and large it represents such goods which are paid for. Indirect use value is, in the main, the consequence of the ecological functions that the environmental resources perform. In the case of forest resources these may be maintenance of hydrological cycle, carbon store, soil conservation, regulating climate, recreation etc., (Mitchell and Carson, 1993).

Indirect use value is much more difficult to comprehend. Recently there has been considerable amount of research on valuation of natural resources, particularly concentrating on non-marketed and non-use situations (Maler, 1991; Dasgupta et al., 1994; IIED, 1994). A large number of environmental services that a society enjoys come from environmental functions performed by natural and environmental resources. Examples are clean air (e.g., through carbon sequestration), ecological balance (e.g., balancing the dependency between bacterial, animal, plant and aquatic life systems), nutritional recycling (e.g., natural assimilation of waste, nitrogen cycle), security (e.g., assuring non-diminishing future consumption rates), aesthetic beauty (e.g., flora and fauna of forests, water bodies, snow-bound mountains), etc. These are in addition to the known economic functions such as energy supply of fossil oil and solids, timber and non-timber products from forests and so on. One is never certain if we have the correct scientific knowledge and judgement about these ecological and economic functions, or estimate of their values in an empirical sense (Pandit, 1997).

Many of these are instances of non-marketed and non-use functions performed by natural resources.

Taking a cue from ecological perceptions, theory of valuation of natural resources have extended concepts of value to encompass Option, Bequest and Non-use values as well. As a consequence, a term total economic valuation has been added to the lexicon of resource economics. Several studies attempt such a total economic valuation.[3]

Non-use values are such values that are independent of people's present use of the resource. Under non-use values fall intrinsic worth and heritage values. These are categorically classified as existence, option and bequest values. Existence value represents the value, which an individual is willing to pay for the environmental amenity, even though (s)he receives no direct benefits. Bequest value refers to an individual's willingness to pay for preservation of a resource for future generations. Option value refers to the willingness of people to keep the option of postponing the decision on the use of the resource now. Option value may, in contrast with bequest value, have a component of future use value. Option value can have both use and non-use components. It is taken as use value in situations where people are asked to pay a fee or tariff to decide about the use of the resource in the future. However, in most other situations such as forests, its non-use value is taken with respect to the present period. Further, non-use value may contain components of bequest value and existence value.

Total economic value (TEV) is then usually defined as the sum of use value (UV) and non-use value (NUV).

$$\begin{aligned} TEV &= UV + NUV \\ &= DUV + IUV + OV + NUV \end{aligned}$$

Where, DUV is Direct Use Value; IUV is Indirect Use Value and, OV is Option Value. Chart 1 shows the various aspects of this total economic value.

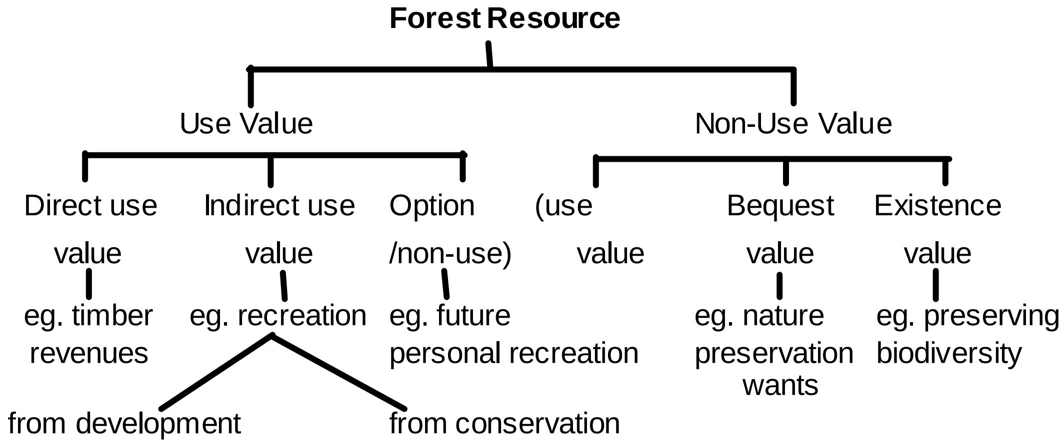

Chart 1 : Kinds of economic values from forest

The pioneers in this century on the question of valuing natural resources were Lotka (1956) and Grey (1914), followed by Harold Hotelling (1931). Lotka (1956) concentrated on valuing life within the framework of biological species. Grey talked about the rent on extracted resource subjected to exhaustibility. Hotelling basically investigated the effects of depletion on welfare. He argued that the optimal rate of extraction of an exhaustible resource is such that the (net) resource price or shadow cost would rise at the same rate as the discount rate.[4] His so-called r per cent rule helped resource planners to price natural resources in order to maximise the discounted inter temporal utility. In a limited sense, he was able to link the value of a natural resource with the discount rate, which is an important parameter in national income accounting. More recently El Serafy (1989) has provided rules for charging rent for exploiting resources at the rates different from the sustainable ones.

Today more and more complex issues related to valuation of natural resources are analyzed, involving issues such as exhaustibility versus renewability, externality associated with natural resources (e.g.,degradation), inter-generational use, development versus preservation use, and so on.

2.1 TECHNIQUES FOR VALUATION

Economic theory postulates that market price reflects the true economic value of resources only when near perfect markets exist. In the context of environmental resources, market price is not relevant, as prices are not easily attached to the ecological functions, which the natural resources perform. For instance, even for timber and non-timber forest products (NTFPs) the existing market price is not indicative of either present or future scarcity due to the imperfections associated with lack of information regarding goods traded, market and policy failures etc., (Bromley 1995; Turner, 1993).

Keeping this in view, different techniques have been developed to assess the true economic value of natural resources and functions provided by them. The available valuation methods can be categorised as price based valuation, surrogate market valuation and artificial or constructed market valuation methods.

1. Market price reflects the economic value of a resource as measured by exchange value. It reflects the revealed preference of an individual to pay for the consumption of a good or service. However, this may not be a good approximation of the true economic value if there is any distortion in price due to the presence of market and policy failures. It may then have to be revised to deduce the full opportunity cost of the resource use to society. Further, in the case of renewable and partially renewable resources, it is only in the particular situation of perfect markets

accompanied by sustainable yields that the market price can be an accurate index of value.[5] The insistence on sustainable yields implies the existence of perfect markets in inter-temporal trading, a somewhat tall order when future preferences (among other things) are unknown.

2. Shadow price referred to as the adjusted price in a strict theoretical sense is obtained from an economy wide optimisation exercise. It would then be a measure of both opportunity cost and willingness to pay. In the literature, however, a variety of second best methods exist to estimate shadow prices. The loss of earnings approach is based on price in the labour market. The loss of earnings is viewed as an index of adverse impact (in terms the benefit foregone) of aspects of the environment such as air quality on health. The opportunity cost is useful for valuing unmarketed goods and measures trade-off between preservation and other marketed goods and services.

All observed prices and "corrected" market price based methods of valuation, aim at estimating the value associated with present use as reflected in the willingness to pay for a good or service, either in money or in real (say labour) terms. In the case of timber for instance, the process of price determination in the auction markets reveals that these can be taken to be near perfect and hence market price is a fairly good approximation of use value.

3. The surrogate market valuation approach uses information relating to a marketed good to infer the value of an associated non-marketed good. Different possible associations can be examined in this context. The hedonic price method, for instance, assumes that the value of a resource is related to net benefits derived from it. In the property value or wage differential approach it is assumed that the change in land or property price due to a change in the environmental amenity reflects the value attached to that amenity. This method evaluates best the differential advantage obtained from extended residence in certain spatially preferred locations. The Travel cost approach treats expenditure incurred on visiting a site as an index of consumer's preference for the services provided by it, and derives therefore the value placed on these services. It is most commonly used for assessing the value of preservation of flora or fauna in protected areas such as national parks.[6] The Production function or alternative technology approaches can best be used for valuing indirect ecological functions of forests.[7] The first views the contribution of a natural resource to economic activities in terms of substitute inputs. Soil conservation may, for instance result in saving in the amounts spent on chemical fertiliser. The alternative technology approach can also be classified as a cost based valuation since the contribution of the natural resource is viewed in terms of the saving effected by not having to resort to an alternate

technology. Soil conservation in upstream forests, for instance, results in a saving in the costs of desilting of downstream water bodies using mechanical dredgers.

4. The price based and surrogate techniques referred above rely on the preferences revealed in the real market. The issue that arises is how to go about valuation if such markets do not exist? In such a situation, the consumer will not be able to link his utility preferences to his budget and hence to the prices. The methodology is to create a situation of stated preference, in which an artificial market situation is created. Contingent Valuation Technique (CV) enables to assess consumers' preferences by constructing hypothetical markets. Contingent valuation method helps in deriving the willingness to pay to continue receiving benefits or willingness to accept compensation in returns for foregoing benefits. The method can be useful in a wide range of situations, in the determination of both use and non-use values. In the context of eco-tourism, it can yield estimates of willingness to pay for preservation of particular species or of whole eco-systems. It is equally useful in assessing use value for locally consumed forest products such as fuel wood and fodder. Contingent ranking, a variation of the CVM relies on non-monetary preference of the respondents. A range of commodities is given for ranking in qualitative rather than monetary terms and then scored. Trade off is used to determine the individual's choices between various outcomes, and a ranking obtained on their basis.

CVM and the genre of methods related to it depend critically on the manner in which respondents are sensitised, hypothetical markets are constructed and schedules canvassed among the users or beneficiaries. They are criticised for certain biases like starting point bias, embedding bias, part whole bias and strategic bias. This criticism emerges from the fact that the consumer is reacting under hypothetical contingencies of a real life decision making process.

The techniques described above are all aimed at estimation of value as measured in a cardinal sense. Of late, there has emerged a view in the literature that ordinal ranking of value is sufficient to arrive at decisions with respect to environmental and economic variables. Multi-criteria analysis provides a framework for such a ranking of alternative sources of value, some of which are defined only in ordinal terms (Janssen and Herwijnen 1994; Munda,1995). The method is however, criticised as requiring exogenously given weights and being an unrealistic characterisation of the decision making process.

5. Decision analysis and risk benefit analysis belongs to a category of techniques similar to multicriteria analysis in so far as they focus on the impossibility of precise estimation. They focus, however on choice

under risk and uncertainty and, unlike multi-criteria analysis, do not have a clear mechanism for assigning weights.

All the techniques described above can be used for valuation of resources in the use and non-use category. However, arising out of the limitations of each technique, alternative methods may be appropriate for different resources. For instance, there is no way of ascertaining prices for indirect uses or services of forests' resources and also for other non-marketed forest resources, which are used for self-consumption. Hence, while direct use value of marketed resources is best determined at market prices, non-marketed goods and the services should be valued using surrogate valuation. Further, the artificial market method and contingent valuation technique, when implemented carefully, could be useful in almost all situations, including that of determining option and other non-use values. Ordinal ranking and valuation, on the other hand, provides a good index of relative values in situations where some values are not quantifiable.

2.2 SOME METHODOLOGICAL PUZZLES

When any environmental resource is valued from various perspectives, using different methods there are bound to have more puzzles in store. One among these is the issue of the additivity of different kinds of values. Most commentators seem to implicitly agree that different kinds of value accruing from a resource constitute a part of so called total economic value. Should estimates of the different kinds be added linearly? In the case of a heterogeneous natural resource such as forest, value accrues from individual resources and from the system as a whole. The existence of a certain species or the performance of ecological functions depends on the health of the eco-system per se. And if this is maintained, the accrual of value from sustainable extraction of component resources such as fuel wood or fodder is subsumed in it. Existence value then has embedded in it a sustainable level of use value. Is it then valid to estimate total economic value by adding up these two, irrespective of the level of resource extraction? It is maintained that empirical estimation of functions linking resilience of forest quality with streams of value accruing there from are an essential input into determining the relevance of additivity of different types of value. These are not easily estimable in the absence of more in depth information on ecological linkages between different components of ecosystems. Ecologists seem to agree by and large that the current state of knowledge makes this a somewhat hazardous enterprise.

Another unresolved methodological puzzle relates to the mutual consistency of different methods of valuation. When viewed from this standpoint, the alternative techniques can be categorised as those based on revealed preference and stated preference, respectively. Market price based techniques fall in the first group and CVM and related techniques in the second. This issue has been commented on at length,[8] in particular in the context of the correspondence between CVM, the Marshallian demand curve and the Hicksian notion of compensating and equivalent variation (Turner 1993).

2.3 VALUE ESTIMATION AND WELFARE ACCRUAL: A digression

Value accruing from product or service results in welfare accrual and alternative methods of valuation is ways of arriving at an approximation to that welfare. The CVM technique, in its estimates of willingness to pay essentially constructs a demand curve of the kind thrown up in market situations. The Marshallian demand curve also documents willingness to pay at different prices as given by the market. One can read from a Marshallian demand curve, as shown in Figure 1, the willingness to pay for a demand or consumption at the rate of x* as the average of the area A per unit of consumption, as against the price P* read from the demand schedule DD. Further, consumer's surplus, is the difference between such willingness to pay and market price and hence a measure of welfare accruing from consumption. However, it has been maintained that consumer's surplus as measured from the Marshallian demand curve measures only the price effect of a change since it does not keep the real income of the consumer constant. A better measure of welfare changes is therefore to be read from the income compensated income demand curve, which captures both the price and income effects (Hoevenagel, 1996; Bateman and Turner, 1993).

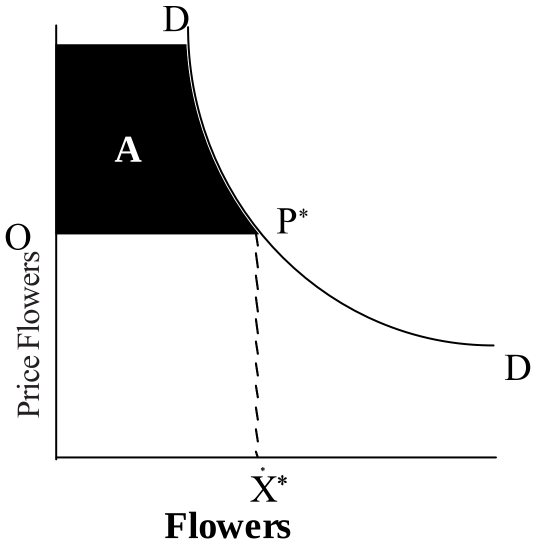

Figure 1 : Estimating willingness to pay on Marshallian demand curve

Welfare measures based on a Hicksian approach and their links with the CVM method are now described briefly. Two types of measures of consumer benefits have been suggested by Hicks, namely compensating variation (CS) and equivalent variation (ES). While the former are calculated by holding the consumer's utility constant at the initial level of demand, the latter are estimated by keeping it constant at some alternative level. Since policy interest usually lies in the potential benefits as measured from the consumer's current or initial level of utility, the choice as between Hicksian measures is often narrowed down to the two compensating surplus ones.

Bateman and Turner (1993) have also pointed out that the variation measures should be applied only when a consumer is free to vary the quantity of the good being demanded. When (s) he is constrained to consume only fixed quantities of it, the compensating surplus measure should be used. When there is an increase in the quantity provided of the environmental good, the measure can be interpreted as the maximum amount that the consumer is willing to pay to retain the increased provision and still remain at his initial level of utility. A CVM survey aims at capturing this measure. Alternatively, in the event of a decrease in environmental goods and services, the compensating surplus will be the minimum amount that the consumers are willing to accept (WTA) in order to be compensated for the decrease and yet remain at his/her initial utility level. Hicksian welfare loss and gain measures associated with CVM measures are given in Box 1.

3. INTEGRATING NATURAL RESOURCE ACCOUNTING WITH INCOME ACCOUNTING

As stated in the UNCED, the main objective of environmental and economic accounting is 'to expand existing systems of national economic accounts in order to integrate environment and social dimensions in the accounting framework, including at least satellite systems of accounts for natural resources in all member states'. The conference document further states that this should be seen as a complement to, rather than a substitute for, traditional national income accounting.

While attempts to derive or assign values to depletion, degradation, and environmental functions have progressed substantially (Hartwick, 1992; Hultkrantz, 1991; El Serafy, 1989; Brandon and Hommann, 1995), the issue of integrating such valuations with income accounting has attained increased significance (Dasgupta et al., 1994). The real issue, briefly, is to provide completeness and consistency in the

BOX 1: HICKSIAN WELFARE MEASURES AND THE CVM APPROACH

Sl.No.	Nature of Effect	Measure
1	Welfare Gain	WTP to ensure that change occures (CS)
2.	Welfare Gain	WTA if gain does not occur (ES)
3.	Welfare Loss	WTP to avoid loss occuring (ES)
4.	Welfare Loss	WTA if loss does occur (CS)

present method of income accounting to arrive at what is currently being coined as 'Green GNP'.

As far as income accounting is concerned, Hicks (1940, 1946) provided the basic principle to define income as a welfare indicator. He advocated the inclusion of all current consumption that does not impoverish future consumption. Consider the case of man-made capital. By now in most countries, national income accounting has evolved methods, thanks to Hicks (1941, 1946), to adjust for the contribution by human-made capital. Stated simply, this human-made capital, as a stock is part of the national wealth. This wealth is used as input in production of commodities and services whose consumption enhances welfare. However, its use may lead to depreciation. If this depreciation is not accounted as a cost in the current income accounts, it will mean a smaller stock of capital for the future and hence a lower level of production and less welfare in the future at the cost of high welfare now. Such an income generation process is not sustainable in the long run. The Hicksian solution accounts for all such depreciation as costs in current income accounting. Capital formation is treated as addition to capital stock and forms part of national income accounting on the expenditure side as a flow.

Can the same logic be extended to exhaustible resources? The case of exhaustible resource is of course different. Extracting it now can in no way assure constancy or improved welfare in the future (unless substitutes arrive). In a non-substituting society (e.g., cake-eating economy), therefore, the Hicksian measure of income from the extraction of an exhaustible resource should be treated as zero. This norm, however, would substantially reduce the incomes of the countries such an OPEC that is heavily dependent on extractive activities. For instance, if any country's income were only from crude oil extractions, then it would imply that its national income would have to be treated as zero! The only solution to this puzzle was given by the modified Hartwick rule (Hartwick, 1990; Dixit, Diamond and Hoel, 1980) which suggests that along the equilibrium path as long as the rental income from the resource is reinvested, the future income stream will remain constant. This also makes investing on capital formation and resource development legitimate expenditures towards welfare.

What about methods of linking valuation with income accounting? Weitzman (1976) among others developed an analytical model linking valuation of capital and other resources with income accounting. In brief, his main result is that the 'Current value Hamiltonian' in an aggregate neo-classical growth model, i.e., the integral of utility over a period, is a welfare indicator. This Hamiltonian is shown to be equivalent to the Net National Product (NNP) of the economy. However, he dealt mainly with the proper valuation of man-made capital equivalent to present value of future stream of consumption and did not deal with valuation of natural resources. Since then, the basic issues associated with natural resources and linking them with income or welfare have attracted increasing interest among economists. Dasgupta, Kristrom and Maler (1994), Hartwick (1992), Howarth (1991), among others, have concentrated on dealing with specific issues such as valuation and inter-generational equity, depletion, degradation, defence against environmental degradation, labour in environmental management, and so on. Most of these developments are in the neo-classical framework of optimising welfare defined as the present value consumption. As argued by Maler (1991) and others, the main advantage of this approach, however, is its direct link with the system of national income accounting. Briefly, this method will be termed as the 'integrated approach'.

The concept of resource accounting started almost two decades back, at the end of the development of methodologies for project evaluation in the early 70's. As reviewed through the literature above, the logic for integrating valuation of natural resources with income accounting is simple at the conceptual level but difficult to operationalise at the empirical level. This point will be elaborated with examples.

Take the case of forest resource. Forests are part of the natural capital of a country. Can one develop an accounting for it as easily as for human-made capital? The answer is 'yes' in theory, but difficult in practice. The major difficulty arises from the distinction between depreciation and depletion. In the case of depreciation, it can remain as a notional value judgement, the same can not be said about natural resources when they actually degrade and deplete. Secondly, accounting for additions to natural capital is not easy. It takes place both through natural regeneration and plantation. For each of these, one ought to have good data and information about the survival rates.[9] In other words, it is not as simple as accounting for capital formation in the usual national income accounting sense. Thirdly, the flow from forest stocks is only partially accounted as legal extractions: much of it is not. Then there are several natural phenomena such as forest fires, landslides, earthquakes, floods etc., on account of which there are changes in this natural capital. In short, physical accounting of forest stock and flows is itself a complex undertaking.

Consider another example that of air quality, an environmental resource for sure. Its accounting will have to take note of the pollution added by the industries (to be valued by their willingness to pay for abatement), the carbon sequestration done by the forestry sector (for which some plantation forestry investments might have been made), additional defensive and preventive investments done by individuals and the government to prevent hazards from degrading air quality, externality costs such as medical expenses incurred by individuals due to degraded air quality and many more. Figure 2 shows an analytical method of deriving the optimum pollution level and the 'polluter pay price' for it. MEB is the marginal benefit from abatement, whereas MEC is the marginal cost of abatement. The level of social tolerance of pollution is OW* whose social value is OC* to be charged as polluter pay charge.

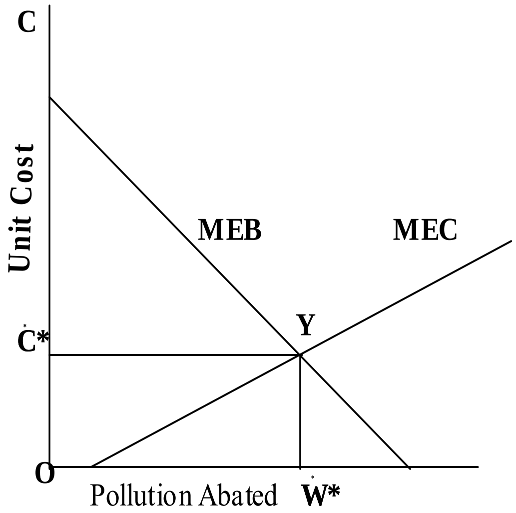

Figure-2 Determining "Pollution pay" for abatement

3.1 EMPIRICAL APPROACHES TO ACCOUNTING

On the empirical side, there have been a number of attempts to quantify the value of natural resources and accounting for their use, and for changes in income accounting, e.g., Hueting (1989), El Serafy (1989), Repetto et al., (1989), Hultkrantz (1991), Brandon and Hommann (1995).

While attempts were on to integrate resource valuation with the System of National Income Accounting (SNA), an approach of satellite accounting was developed by UN agencies (UN, 1993) and also independently by countries such as Norway (Alfsen and Torstein, 1990), the Netherlands (NCBS, 1993) and several others. Under this alternative, as suggested by several scholars (CBS, 1993; Peskin, 1989), stock and flow changes in environmental resources be to be treated in a separate table, leaving the basic income accounting table unchanged.

Parikh et al. (1992), UNDP (1993), UNEP (1993), Kulshreshtha (1997), Peskin (1989), among many others have suggested methods of correcting national income accounting by going back to the basic structure of the macro economy seen in terms of an Input-Output table. This basis comes from Leontief (1966) and Stone (1961). The approach starts with identifying all such sectors which are environmentally and natural resource-wise important. Then, each of these are divided into sub-blocks in terms of supply sectors/factors as well as demand or receiving sectors/factors, isolating the natural resource and environmental factors. Flows of outputs or services from those natural and environmental resources (or factors) used as inputs by others are to be identified. Additional columns of consumption, to account for flows from natural and environmental resources directly in the form of final use, are also incorporated. The modified Input-Output table can be used to define the adjusted value added as well as final consumption, accounting for environmental and natural resource uses. In this manner, one would have accounted for the use of natural resources both as intermediate inputs as well as final use consumption. The method is quite appealing, simple in description, but is too complicated to implement. Economists need not be reminded about the complexities in estimating even the regular Input-Output tables of an economy.

Parikh and Parikh in a recent study (1997) have further elaborated the System of Environmental and Economic Accounting (SEEA) as developed by the United Nations. Figure 3 illustrates their methodology of developing integrated stock and flow accounts within the framework of national income accountings. They also provide a definition of Green NNP as:

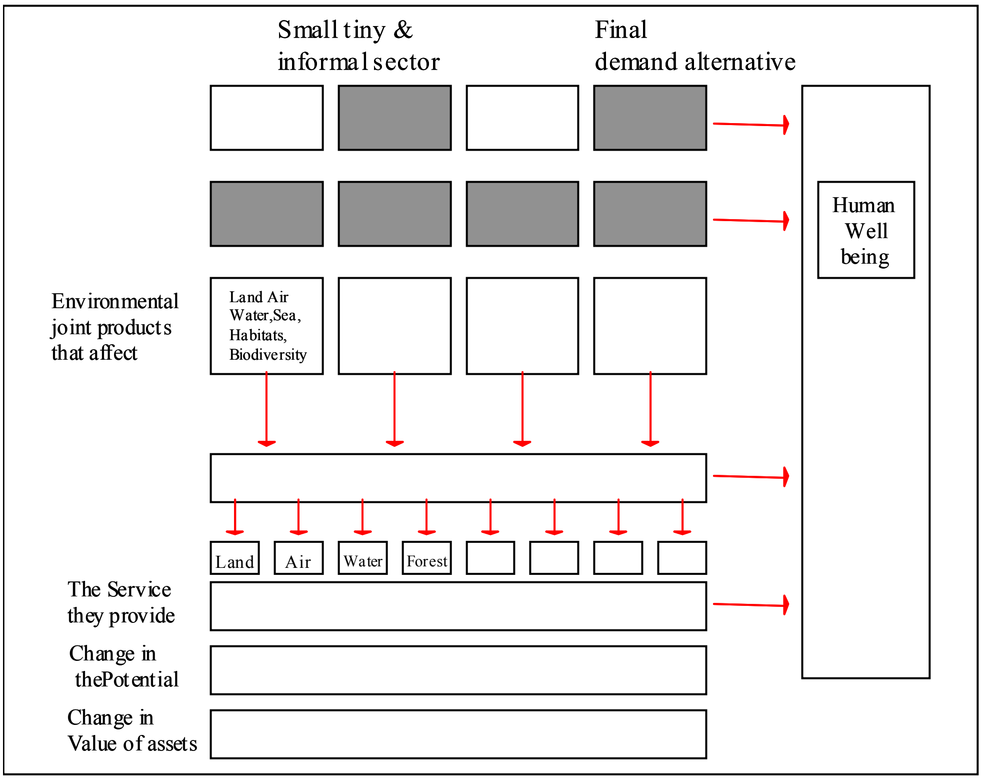

Figure 3 : Integrated Environment and Economic Accounting

Net National Product= Value of consumption
+Value of production of nature collected (such as fuelwood)
+Value of environmental amenities provided by environmental resource stocks (such as clean air etc.,)
+ Value of leisure enjoyed
+Value of additions to production capital
+Value of additions to natural capital stocks (such as forests)
+ Value of additions to stock of defensive capital.

While they do not recommend deduction of defensive expenses from the category of consumption in the definition of NNP, but recommend it for the satellite accounting.

Hueting (1989) of course, always advocated basing income accounting on a concept of standard sustainable use. In the context of the actual defensive expenses (against environmental degradation), for instance, he suggests deducting the gap between the cost of maintaining 'sustainable use as against actual use of natural resources'. It is in this sense that his method of accounting also falls in the category of satellite accounting.

The main achievements so far in empirically linking natural resource valuation with income accounting is summarised in Box 2:

Box 2: Progress in empirically obtaining valuation and integration with income accounting

** Depletion accounting by either 'User cost method' or based on a 'depletion rate',
** Improving estimates on 'use values' by various methods such as hedonic price, travel cost method replacement value methods etc.
** Incorporation of a number of Non-use values, such as option value, existance value, bequest value, and so on, based on 'contingent value' method,
** Satellite accounting for natural resource degradation and regeneration.

A number of issues that ought to be addressed further, at both the theoretical and empirical levels still remain. Some of the major ones are mentioned here.

** In what manner should the costs incurred by a society on abating environmental degradation by incurring 'defensive expenses'[10] be treated? Can one define the 'sustainable use of resources' and the associated hypothetical defensive expenses? Even if such an estimate is made, how does one put it within the framework of SNA 1993? For example, how does one account for expenditures to get clean air, which is made scarce due to forest degradation? A related issue is how to account within the SNA for the externality benefits derived from consuming or enjoying environmental resources without paying for them (e.g., enjoying recreation benefits from forests such as watching birds or wildlife without paying for it)?

** Income accounting is a balance between income and expenditure. It is not enough to account for externality only at the level of expenditures (e.g., defensive or unpaid). One also has to account at the income or value added levels. How does one deal with income earned from working with environmental management programmes? Do such purely abatement programmes, resulting from a situation of disequilibrium, add to welfare in the sense that the value added is not matched by expenditures contributing to welfare?

** What is the validity of dealing with only a select list of natural resources for accounting and integrating with the SNA, when the natural resource endowments of an economy consist of many more such resources? The notable ones that are normally left out are renewable resources and biodiversity.

** Accounting for welfare implications of preservation benefit, which, in a strict theoretical sense, does not add to current welfare or utility. This issue gets more complicated particularly because of the fact that preservation can be costless. But it involves, sacrifice of current consumption from developmental use of natural resources.

** While talking of environmental services provided by environmental functions, one is not sure if one will not end up double counting. For instance, timber after felling from the forest has a price reflecting its use or utility value. But it has emerged out of the carbon sequestration function of the forest, abating global climate change (i.e., having a non-use value). Now how does one segregate its use and non-use values? To further complicate matters, what is to be done if the security value of forests is also to be accounted along with the timber and non-timber values?

** The task of integrating the values of natural resources with national income accounting has one problem. The values of environmental resources are elicited, broadly based on two methods, namely, revealed preference values and stated preference values. Values derived from market prices refer to revealed preferences. Many others are based on stated preferences (e.g., ‘non-use’ values or even ‘use’ values for non-marketed goods and services deduced from the contingent valuation method). It is here that an inconsistency can arise when all such values are to be aggregated, knowing that different valuation methods follow different pricing systems. Only some empirical norms of adding such revealed and stated preference values have been developed (Carson et al., 1995).

Therefore, the task of bringing valuation and income accounting closer is still far from complete. On a theoretical basis, there is no guarantee of an integration of these two, so as to arrive at a system of adjusted national income accounts (UN, 1993). Therefore, either one may have to resort to 'satellite accounting', or the 'integrated approach' suggested by Weitzman and many others may have to be operationalized.

4: A MODEL OF INTEGRATING RESOURCE ACCOUNTS WITH INCOME ACCOUNTING

Since valuation and accounting are like two sides of the same coin, they should be linked properly for any useful policy purposes. Therefore, it is preferable to derive and link them within one single model. Kadekodi and Agarwal (1998) have developed a model of welfare in which the consumption of normal goods and services and enjoying natural resource and environmental goods and services through preservation are incorporated. Expenditures of income on defensive expenses and preservation are built in. The resource depletions, be they exhaustible or renewable, are also to be specified. Regeneration of environmental goods is treated as an additional economic activity. Willingness to pay for preservation and for the consumption of normal goods and services are also accounted for. Degradation of natural resources is treated as a quality index. They derive, under a utility maximisation principle, the Adjusted Net Domestic Product (ANDP) distinct from the traditionally defined NDP (See Annex for the mathematical expression).

The adjusted net domestic product then will be:

The usual UN definition of net domestic product,

(-) adjustment for exhaustion of depletable natural resources (with appropriate shadow prices)

(-) social cost of degradation of environmental quality (again in appropriate shadow prices)

(+) preservation benefits enjoyed by the society (for which no payment is made)

(+) employment benefit of labour employed in preservation activities (valued in terms of its own opportunity costs)

(+) regeneration cost incurred (valued in shadow prices).

A number of implications follow from the adjusted and integrated income accountings as summered in Box 3.

incurred to maintain the same level of utility as before the emergence of environmental degradation.

> Box - 3 Adjusted National Income
>
> ** The effect of degradation itself can be divided into two parts, one representing the direct degradation effect, and the other the indirect effect due to net regeneration (i.e.,after deducting for depletion). Both these externalities are to be valued in terms of the shadow price of quality of the resource. Alternatively, these two can also be expressed as two separate effects, one representing degradation effect and the other that of regeneration. In that case, both of them are to be valued in terms of their respective shadow prices.
>
> ** The depletion effect on income is directly captured in terms of its marginal productivity of the adjusted extraction rate.
>
> ** Cost of preservation benefits must be included as part of income, after imputing it using appropriate prices. This in fact represents the preservation benefits. This benefit is at the cost of using some part of the normal good and the additional labour time spent on enjoying it.

A special mention must be made regarding defensive expenses. These constitute such expenses, which the society incurs as precautionary, against facing the externality effects of environmental degradation. Defensive expenses are currently hidden within the normal consumption expenses. Examples are buying of a health insurance against illness attributable to pollution, or degradation of water quality. Another example could be 'purchase of purified water in bottles', even in the glacier region on the bed of the river Ganga near Gangotri or Yamunotri. All such expenses that individuals incur as a precautionary measure, in order to avoid implication of environmental degradation will be called defensive expenses. These expenses are incurred as part of other consumption expenses. They are said to be

The production of defensive goods and services do require both labour and capital as in the production of any other normal good. From the demand side, there are two ways in which defensive expenses can be treated for valuation and accounting purposes. First, it can be considered as part of consumption expenditure. Alternatively, it can be treated as a negative regeneration, i.e., substitution instead of regeneration, which is only a special case of regeneration, mentioned earlier.

Take the case of treating defensive expenses as consumption. Individuals can opt once for all, to invest on defensive goods (or services) as a precautionary measure,[11] or incur medical and other expenses as and when they are affected by the exposure to the risk of environmental degradation. In the second instance, there is a chance associated about the individual falling sick or being affected by degradation. Considering a probability p of an individual falling sick due to environmental degradation (in the absence of defensive expenditures), the optimal investment on defensive expenditures can be deduced, which ought to be incorporated as part of the adjusted national income (Kadekodi and Agarwal, 1998).

5: ADJUSTING FOR FOREST RESOURCE ACCOUNTS: AN ILLUSTRATION

The valuation and integration methodologies are illustrated with a case study of forest resources from Yamuna basin in India.[12] The Yamuna sub-basin covers four states and the National Capital Territory of Delhi (NCT). The four states are Haryana, Himachal Pradesh, Uttar Pradesh and Rajasthan.

A large variety of forest types and sub-types are distinguishable in terms of density and species. They have to be viewed both as a stock and as the source of a series of flows. The stocks are measurable in terms of forest area and growing stock rates. Biomass stock is, however, only one component of the stock measure. The other components are stock of forest knowledge (from which there is a flow of medicinal values, spiritual values, aesthetic values etc.), nutritional balance, bio-diversity or social security.[13] Such stocks or wealth are very difficult to comprehend and evaluate. What follows from the stock is the flow. The forest flows are: timber of different kinds, fuel wood, fodder, hides, medicinal substances, roots, herbs, shoots, fruits, barks, flowers and other non-timber forest products. Then there are a large number of forest functions and services such as religious services, tourist flows, security, aesthetic beauty, carbon sequestration, nutritional cycling and so on. It is the flow accounting that is of immediate relevance for income accounting.

How to value the stocks and flows? This requires both physical accounting and prices or unit values. Physical accounting of many of the stock and flow components is equally difficult. Apart from matching data from alternative sources such as Forest Survey of India (FSI), National Remote Sensing Agency (NRSA) and Working Plans of forest departments, both ground truthing and sample surveys to collect opinions about the state of the forests are to be carried out. Estimates of legal and so-called illegal extractions are also to be assessed from various agencies. In brief, data on forest area by types of forests, biomass (i.e., growing stocks), extractions, losses due to various factors are to be compiled for purposes of physical accounting.

The flows of goods and services, the use value of which are estimated as a consequence of these exercises are:

(1) Timber and some non-timber products (using auction data and CVM techniques),

(2) Services of tourism and recreation in selected national parks (using travel cost method),

(3) Consumption of forest products by people living in their vicinity (using CVM technique), and

(4) Accrual of perceived ecological services to people living in or near forests (using both CVM techniques and Multi-criteria methods).

The relative value attached to different kinds of use and non-use value can be analysed using multi-criteria based techniques. After valuation studies follows the basic question of accounting for forest as a natural capital in national income accounting. At present, only some of the flows of products from forest sector are accounted in Indian national income accounting. They are industrial wood, fuel wood and some minor forest products. While the first two are based on some kinds of data coming from state forest departments, the third is more or less notional, a percentage figure being derived from limited evidence. In any case, illegal extractions of all kinds of products and contributions from forest on other accounts as mentioned earlier do not figure in the accounts. When it comes to valuation, some prices are used, by and large, the state trading corporations' auction prices. When viewing natural capital, these prices do not in any way reflect the utility or willingness to pay.

Four different aspects of a typical forest are to be accounted. They are extraction, regeneration, degradation, and preservation. An attempt is made here to demonstrate the possibility of arriving at adjustments to the corresponding state domestic incomes for the states falling in this sub-basin on account of changes in forest resource stock and flows by using these four components.

Following the methodology developed by Kadekodi and Agarwal (1998), briefly described earlier in section 4, the parameters and data that are required to make the adjustments in the corresponding net state domestic products (NSDP) for each state are described here.

To begin with, one needs the estimates of current net state domestic products (NSDP) for the states of Haryana, Himachal Pradesh, Uttar Pradesh and Rajasthan (leaving out NCT for the moment due to its low levels of forest resources). The state domestic products for all these states are available in published form only up to 1988-89. Keeping the accounting year for forest resource accounting as 1995-96, the state domestic products for the individual states have been projected using regression trend techniques. Also projected are the recorded incomes (or valued added) by the Forestry and Logging sector in these states.

All other data and parameters are taken from the major study by Chopra and Kadekodi (1997). They are briefly described here.

1. Annual forest degradation rate (A): Being an indicator of quality change, this can be taken as the change in total area of well-stocked forest area. In this illustration, the rate of area degradation among the dense forests is considered.[14]

2. Shadow value of degradation (μa): Corresponding to the definition of degradation, the shadow value of it has to be in rupees per unit area. This shall be based on the estimated Willingness to Pay (WTP), which reflects the opportunity value of losing a well-stocked forest such as a dense forest.

3. Regeneration rate (H): For this the annual increments (m3 per hectare) can be used.

4. Extraction rate (R): This is taken to be the same as annual productivity m3 per hectare).

5. Total dense forest area (TDA): This is the relevant forest area for which perhaps the regeneration and extraction features are applicable. In the open forest areas, either the regeneration rate (mostly under plantation of fuelwood under JFM, SF., etc.) just equals the extraction rate, or their difference is very marginal. Therefore, there may not be any net change in biomass from such areas on account of regeneration and extraction.

6. Shadow price of stock of forest resource (μ s): For want of any better estimate, the timber price is used for purposes of demonstrating the methodology. The true value should be the ecological value of the biomass, which should include timber, NTFP, ecological function values, etc. As and when a better estimate of this parameter based on ecological and other environmental functions is obtained, it can replace the value used here.[15]

7. The preservation value per year (P): This is taken only for Bharatpur National Park, as an illustration. The net contribution of the tourists per year for this park based on the travel cost method can be taken as adding to the preservation benefits in Rajasthan. As and when more and complete information from all the parks is available it can be introduced under the same methodology. If such preservation values are added here, the corresponding tourist values will have to be subtracted from the usual estimates of SDP. The preservation value from the national park need not be equal to the tourism value as recorded in the national income accounts.

Table 1 : Income adjustment in Yamuna basin

State	Degradation≡Annual change in dense forest area during 1995-96	Shadow value of degradation ≡ WTP	Regeneration rate=Annual increment	Extraction rate=Annual productivity	Total dense forest area in 1996	Shadow price of stock of forest≡Timber price	Preservation benefit = Tourist travel cost
	A:sq.km.	μa:Rs/sq.km.	H:m3/ha	R:m3/ha	TDA:ha	μs:Rs/m3	P:Rs lakhs/Year
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rajasthan	-36.04	107232	0.22	0.555	39388	12360	576
UP	-18.74	32006	1.71	5.380	157136	8279	0
HP	107.40	17600	1.28	3.490	139967	8279	0
Haryana	-7.06	353001	0.53	0.440	3882	18540	0
Total Yamuna basin	45.56		1.05	2.460	340373		

Tables 1 and 2 show the estimated data, parameters, and the computation of adjusted income in the states, on account of changes in the forests of the Yamuna sub-basin.

Table 2: Adjusted State Domestic Product in Yamuna Basin states (Figures in Rs lakhs)

State	Net state dom. product in 1995-96	SDP from forestry and logging	Adjustment on account of forest flows 1	Relative Adjustment
	Projected from 1980-81 to 1988-89 data	Projected from 1980-81 to 1988-89 data	0.78*μa.A+μs.TDA+(H-R)+P	Ratio in Percentage
(1)	(2)	(3)	(4)=(From Table 1) :0.78*(2)*(3)+(7)*(6)*[(4)-(5)]+(8)	(5)=(4)/(2)%
Rajasthan	259216	8239	-1661	-0.64
UP	755378	13334	-47749	-6.32
HP	37286	14434	-25594	-68.64
Haryana	175162	2847	+46	+0.03

Notes: 1.The adjustments shown in column 4 shows the additional corrections, after according for the contribution made by the forestry and logging sector in terms of value added. A factor of 0.78 is applied to WTP estimates to convert stated preference values into revealed preference values. See Carson et al.,(1995). Asterisk * stands for multiplication sign.

Some comments on the database on SDP are in order. Data on State Domestic Product in Himachal Pradesh during 1980-81 to 1988-89 show that the income from forestry and logging dominated (77 per cent in 1980-81, 69 per cent in 1988-89) the total SDP. Because of such a dominance, any depletion of forests in this state will mean considerable impact on the state domestic products. This, precisely, is what is reflected in the estimates shown in Table 2. If we are ever to adjust the SDP of Himachal Pradesh, on account of excessive extraction over and above regeneration, the adjusted income can go down by a much as 68.64 per cent.

The estimates of adjustments for other states are -0.64 per cent for Rajasthan, -6.32 per cent for Uttar Pradesh, and +0.03 per cent for Haryana. The positive adjustment in Haryana is perhaps attributable to recent JFM and other community programmes. The marginal decline in Rajasthan is indicative of the stress on account of fuelwood shortages. In the case of Uttar Pradesh, it is a case of excessive extraction on and above the regeneration rates.

6: ACCOUNTING FOR WATER QUALITY: AN ILLUSTRATION

This section is devoted to a demonstration of valuation of water quality degradation with income accounting. For this purpose the expression for adjusted net domestic product as shown in Annex is used. The following general parametric assumptions are made here:

1. Let the marginal productivity of labour be equal to the market wage rate and that of preservation equal to the average willingness to pay to avail preservation benefits. This latter can be based on a 'Travel cost method'.

2. The elasticity of GDP w.r.t. n (=A.R), θ, can be expressed in terms of elasticities of GDP w.r.t. R,(θR), and resource quality A, (θA), as:

$$1/\theta = 1/\theta A + 1/\theta R$$

Subsequently, it is assumed that $\theta R = 0.5$ and$\theta A = 0.1$. This yields the estimate of

.

$$\theta = 0.083.$$

Alternatively, Leontief production behaviour can be assumed. This will imply that the marginal productivity to be equal to the average productivity, which is equal to the inverse of the Leontief coefficient. Then can be expressed as the ratio of the value of resource used as intermediate input to gross output.

3. Let the shadow price of capital be equal to unity.

4. Define the elasticity of preservation benefit w.r.t. the time spent as $\alpha = (\partial P/\partial Lp)/(Lp/P)$. α can be safely assumed to be unity.

5. Let the expenditure on preservation benefits enjoyed by the people, i.e., $\pi p.P$, be assumed to be 0.5 percent of the income.

The method is now demonstrated with a case study on water resource from the National Capital Territory (NCT). Based on some preliminary estimates made by National Environmental Engineering Research Institute (NEERI) for the year 1995, the following estimates are available. The figures, however, may still be treated as tentative.

1. The state domestic product of NCT in 1995 is estimated to be Rs 18,230 crores in current prices. No direct estimate of capital depreciation was available. Therefore, a notional figure of Rs 100 crores is assumed for it ($=\delta.K$), only for illustration.

2. The water quality in NCT is deteriorating. Between 1991 and 1995, the following changes in quantity of water used (i.e., extraction) and quality were noticed.

(a) The quantum of water used went up from 1027 to 1330 MCM per year. This amounts to a 29.5 per cent increase.

(b) Wastewater discharge went up from 745 to 835 MCM per year, amounting to a 12.08 per cent rise. This is treated as quality deterioration.

Accordingly, the elasticity of water quality w.r.t. Extraction rate is estimated as: η=0.409.

3. In the absence of a precise indicator of water quality, it is difficult to define g(R,K). As a crude measure, the ratio of (water resource stock minus wastewater) to water stock is treated as an indicator of water quality (=A). For the years 1991 and 1995, they are estimated as 0.6126 and 0.4209, respectively. Therefore, the average annual change in water quality works out to -0.0479.

4. Two components of water quality improvement costs are considered. They are (a) treatment cost of wastewater, and (b) cost of electrodialysis of water. Their annualised costs were Rs 45.98 and Rs 652.42 crores per year in 1995. The cost per unit of water quality A (defined above), works out to Rs 1,659. This is treated as shadow cost of water quality (μ).

5. The wage rate in the NCT is assumed to be Rs.50 per person day. In the absence of precise data, the amount of labour time spent on water related recreation (i.e., enjoying preservation) in the NCT is assumed to be negligible. Yet, a notional figure of 0.001 crore-person days is assigned for Lp.

6. Using the expression for ANDP shown in Annex, the change in SDP, attributable to water resource accounting, can be expressed as:

Δ SDP= $-\theta$[Unadjusted SDP]$-\delta.K+(1-\theta).(\pi p.P)+\mu a.(1-\eta).A+w.\ \alpha\ L\ p)$

The estimated value of this adjustment is Rs 1449 crores.

Accordingly, the adjusted SDP of the NCT on account of water use, degradation in quality, and recreation benefits, is Rs 16,781. This amounts to an environmental adjustment in SDP by -7.948 per cent.

ANNEXURE : THE EXPRESSION FOR THE ADJUSTED NET DOMESTIC PRODUCT (ANDP)

ANDP =

$= (Y - \delta.K) + \mu a / \mu k . A . [g (R, K) + \partial g / \partial R . (H - R)] + \partial Y / \partial n . A. (H - R)$

$= (Y - \delta.K) + \mu a / \mu k . \text{Å} + \mu s / \mu k. (H - R) + P. [(\partial Y/\partial Ly) / (\partial P/\partial Lp)]$

$= (1-\theta)[C+\pi_p . P + K + \delta.K] - \delta. K+ \mu a / \mu k . (1-\eta) . g(R, K) . A + P[(\partial Y/\partial Ly) / (\partial P/\partial Lp)]$

where, Y = Output (or GDP),
C = Consumption,
K = Capital stock,
R = Rate of extraction,
A = Quality index of environment,
H = Regeneration rate,
n = A . R,
g(R,K) = Å,
Ly, Lp = Labour in output and preservation activities,
μa = shadow price of degradation,
μk = shadow price of capital,
θ = elasticity of output w.r.t weighted index of resource extracted,
η = elasticity of rate of degeneration w.r.t. the resource extraction,
π_p = cost of preservation,
δ = social discount rate.

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End Notes

1 According to him 'productive forests' are for production and human use and for rearing elephants. Non-productive forests are those reserved "for ascetics, recreation and as wild life sanctuaries". He had even drawn a list of forest products to be accounted for. The list is remarkably exhaustive, with both timber and non-timber products finding mention. The notable ones among them are: timber (teak, pine, hardwood and sal), varieties of bamboo and reeds, creepers, fibrous plants, rope making grass, leaves, flowers for extracting colours, medicinal plants and poisonous plants. He developed an accounting method for a number of commodities and services obtained from forests and game sanctuaries. For some details of what Kautilya had dealt with respect of forest resources, attention may be drawn to Arthashastra, Book 2, and chapters 2,5,,6,17 and 18. A brief account of these in English however is available in Rangarajan (1987). He also provided a mechanism of accounting in a tabular form. Somewhat in line with the main focus of his work, a form of accounting was evolved with the purpose of helping the king to raise revenue by taxation.

2 An enthused reader can go through Hicks (1946), Samuelson (1963) and Debreau(1959).

3 See IIED (1994) for a comprehensive review of studies on valuation with specific reference to tropical forests.

4 Hotelling did not consider extraction costs explicitly; hence his rule is often called the 'naive Hotelling rule'. This rule has been expanded to include a number of alternative situations including extraction costs under alternative market conditions (Dasgupta and Heal,1979; Hartwick, 1990; Kadekodi, 1982); the shadow rent then would rise at a rate less than the discount rate.

5 Penido-Vasquez (1992) estimated economic returns from forest conservation in the Peruvian Amazon. The returns to timber salvaging were estimated using field based timber inventory data, production cost and price data. Valuation of NTFPs can also be done using this approach.

6 See among others, Tobias and Mendelson (1991) and Navrud and Mungatana(1994).

7 Anderson (1987) uses production function approach to value ecological benefits of afforestation in Nigeria. Benefits include preventing decline in soil fertility, increased output and livestock production. Market prices for output were taken to find economic value.

8 See Carson et al. (1995) and the articles in Bateman and Turner edited (1993)

9 Regeneration rates are specific to 'forest type and location', whereas plantation activity has varying survival rates corresponding to it. Both are affected crucially by levels of biotic interference.

10 A defensive expense is that part of income which is spent on goods, the consumption of which does not actually add to welfare but instead helps to maintain old levels of welfare by protecting against environmental hazards. A good example is the buying of health insurance against health problems likely to arise due to environmental degradation. Another example is the purchase of a water purifier as protection against bad water quality.

11 It is assumed that, with such a precautionary measure, the individual has avoided the chance of being affected by the environmental degradation.

12 This case study is based on a major study carried out by Kanchan Chopra and Gopal kadekodi (1987).

13 Kautilya had recognised these. He advised the king Chandragupta to reserve separate forests for vedic learning, soma plantation, safety patches for movements, and parks for recreation (See Arthashastra, book 2, chapter 2).

14 There are also further degradations among open forests. But since most of the open forests are already under the category of degradaded forests, it has not been possible to further add another qualitative change, except to admit that more physical or quantitative change has taken place.

15 There are some estimates of NTFP values in Yamuna basin. It is generally stated to be about 30 percent of timber value, which is considered to be too low. But no precise estimates of other ecological values are available in rupee terms.